AMENDMENTS TO THE CLAIMS

1. (Currently amended) A method for inspecting a bump electrode comprising the steps of :

illuminating a substrate in an oblique direction where balls are arrayed by using an annular type illumination device to form a ring-shaped annular pattern;

photographing the substrate from above the substrate;

correcting a gradation of the photographed image of ~~an~~ the annular pattern by using a function with a saturation characteristic;

making a segmented image which includes an image corresponding to at least one ball; and

determining whether each bump electrode is an acceptable product or not by pattern matching by calculating a normalized correlation coefficient between the segmented image and a template image prepared in advance.

2. (Original) The method according to claim 1, wherein the template image for pattern matching is prepared by using a mathematical formula model representing a luminance distribution.

3. (Original) The method according to claim 1, wherein said step of determining further includes the step of pattern matching by calculating a plurality of normalized correlation coefficients between the segmented image and a plurality of template images corresponding to sizes of a bump electrode to be inspected so that the size of the bump electrode can be determined.

4. (Original) The method according to claim 2, wherein said step of determining further includes the step of pattern matching by calculating a plurality of normalized correlation coefficients between the segmented image and a plurality of template images corresponding to sizes of a bump electrode to be inspected so that the size of the bump electrode can be determined.

5. (Original) The method according to claim 1, wherein the template image for pattern matching is prepared using the following formula representing a luminance distribution:

$I(R, r, d) = 255 \times \exp\{-(R-r/d)^2\}$,

where I is a luminance value of a template image; R is a distance from a center of the template image to an arbitrary point on the template image; r is a parameter for determining a radius of an annular pattern; and d is a parameter for determining a thickness of an annular pattern.

6. (Original) The method according to claim 1, wherein said function with a saturation characteristic used in said step of correcting a gradation of the photographed image is obtained from the following formula:

$I_{out} = 255 \times (I_{in} / 255)^{\gamma}$,

where I_{in} is the luminance value of the photographed image; I_{out} is the luminance value after gradation correction; and γ is a parameter for adjusting the saturation characteristic.

7. (Original) The method according to claim 1, wherein said step of determining whether each bump electrode is an acceptable product or not includes the step of using a single template image corresponding to an acceptable product to calculate the normalized correlation coefficient.

8. (Original) The method according to claim 1, wherein said step of determining whether each bump electrode is an acceptable product or not includes the step of using a plurality of template images corresponding to at least a large size product, an acceptable size product and a small size product, respectively, to calculate a plurality of normalized correlation coefficients.

9. (Currently amended) An apparatus for inspecting a bump electrode comprising:

an illumination device, said illumination device illuminating a substrate in an oblique direction where balls are arrayed to form a ring-shaped annular pattern;

an image pick-up device, said image pick-up device photographing the substrate from above the substrate;

an image processing device, said image processing device correcting a gradation of the photographed image of ~~an~~ the annular pattern by using a function with a saturation characteristic, making a segmented image which includes an image corresponding to at least one ball and determining whether each bump electrode is an acceptable product or not by pattern matching by calculating a normalized correlation coefficient between the segmented image and a template image prepared in advance.

10. (Original) The apparatus according to claim 9, wherein the template image for pattern matching is prepared by using a mathematical formula model representing a luminance distribution.

11. (Original) The apparatus according to claim 9, wherein the pattern matching is performed by calculating a plurality of normalized correlation coefficients between the segmented image and a plurality of template images corresponding to sizes of a bump electrode to be inspected so that the size of the bump electrode can be determined.

12. (Original) The apparatus according to claim 10, wherein the pattern matching is performed by calculating a plurality of normalized correlation coefficients between the segmented image and a plurality of template images corresponding to sizes of a bump electrode to be inspected so that the size of the bump electrode can be determined.

13. (Original) The apparatus according to claim 9, wherein the template image for pattern matching is prepared using the following formula representing a luminance distribution:

$I(R, r, d) = 255 \times \exp\{-(R-r/d)^2\}$,

where I is a luminance value of a template image; R is a distance from a center of the template image to an arbitrary point on the template image; r is a parameter for determining a

radius of an annular pattern; and d is a parameter for determining a thickness of an annular pattern.

14. (Original) The apparatus according to claim 9, wherein said function with a saturation characteristic for correcting a gradation of the photographed image is obtained from the following formula:

$I_{out} = 255 \times (I_{in} / 255)^{\gamma}$,

where I_{in} is the luminance value of the photographed image; I_{out} is the luminance value after gradation correction; and γ is a parameter for adjusting the saturation characteristic.

15. (Original) The apparatus according to claim 9, wherein said image processing device determines whether each bump electrode is an acceptable product or not by using a single template image corresponding to an acceptable product to calculate the normalized correlation coefficient.

16. (Original) The apparatus according to claim 9, wherein said image processing device determines whether each bump electrode is an acceptable product or not by using a plurality of template images corresponding to at least a large size product, an acceptable size product and a small size product, respectively, to calculate a plurality of normalized correlation coefficients.

17. (New) The method according to claim 1, wherein said ring-shaped annular pattern is not fully circular due to partial darkness.

18. (New) The apparatus according to claim 9, wherein said ring-shaped annular pattern is not fully circular due to partial darkness.